1911
PRINCETON, N. J.

Technical Paper 3

DEPARTMENT OF THE INTERIOR
**BUREAU OF MINES**
JOSEPH A. HOLMES, DIRECTOR

SPECIFICATIONS FOR THE

# PURCHASE OF FUEL OIL
# FOR THE GOVERNMENT

WITH DIRECTIONS FOR

# SAMPLING OIL AND NATURAL GAS

BY

IRVING C. ALLEN

WASHINGTON
GOVERNMENT PRINTING OFFICE
1911

# CONTENTS.

Page.
General statement ........ 3
The purchase of fuel oil ........ 4
    General specifications ........ 4
    Sampling ........ 5
    Causes for rejection ........ 5
    Price and payment ........ 5
Determination of weight from volume ........ 6
Reporting analyses of fuel oil ........ 6
Sampling petroleum or fuel oil ........ 7
    General statement ........ 7
    Sampling wagon deliveries ........ 8
        Sampling with a dipper ........ 8
        Continuous sampling ........ 8
        Mixed samples ........ 8
    Sampling a large tank or reservoir ........ 9
    Sampling a single drum ........ 10
    Forwarding samples ........ 10
Sampling gas from a well ........ 11
Publications on fuel testing ........ 12

# SPECIFICATIONS FOR THE PURCHASE OF FUEL OIL FOR THE GOVERNMENT, WITH DIRECTIONS FOR SAMPLING OIL AND NATURAL GAS.

By IRVING C. ALLEN.

## GENERAL STATEMENT.

Until within a few years fuels were generally bought solely on the statement of the seller. The consumer made little effort to find whether value was received for the price paid, but relied on the integrity of the dealer and the brand or trade name of the fuel.

Recently, however, the plan of purchasing coal according to specifications of quality, especially heating value, has gained favor. This plan has been adopted by various bureaus of the Government and by many private corporations, and the total quantity of coal bought under such specifications now amounts to millions of tons yearly. The specifications in use differ in detail, but those that are most precise provide for payment on the basis of the heating value and the ash, moisture, and sulphur content of the fuel as delivered.

In consequence of the success that has attended the use of heating-value specifications in buying and selling coal there has arisen a demand for similar specifications, based on careful tests, to govern the purchase of fuel oils and the refined products of petroleum. These specifications, to be satisfactory, should establish not only the heating value of the oil, and thus show, like the specifications for coal, the number of heat units the purchaser obtains for a given price per unit quantity of fuel, but also the physical character of the oil, its flash point and burning point, and the quantity of extraneous matter it contains.

It is evident that an essential feature of any such plan of purchasing oil in bulk is an equitable method of sampling deliveries—that is, a method that insures the taking of representative samples.

The Bureau of Mines has received many inquiries from Government bureaus and from private concerns regarding fuel-oil specifications and the sampling of purchases. In reply to these inquiries the bureau issues this paper, which, although intended primarily for the guidance of Government officials, may be of service, the bureau trusts, to all persons who buy or sell fuel oil.

## THE PURCHASE OF FUEL OIL.

### GENERAL SPECIFICATIONS.

(1) In determining the award of a contract, consideration will be given to the quality of the fuel offered by the bidders, as well as the price, and should it appear to be to the best interest of the Government to award a contract at a higher price than that named in the lowest bid or bids received, the contract will be so awarded.

(2) Fuel oil should be either a natural homogeneous oil or a homogeneous residue from a natural oil; if the latter, all constituents having a low flash point should have been removed by distillation; it should not be composed of a light oil and a heavy residue mixed in such proportions as to give the density desired.

(3) It should not have been distilled at a temperature high enough to burn it, nor at a temperature so high that flecks of carbonaceous matter began to separate.

(4) It should not flash below 60° C. (140° F.) in a closed Abel-Pensky or Pensky-Martens tester.

(5) Its specific gravity should range from 0.85 to 0.96 at 15° C. (59° F.); the oil should be rejected if its specific gravity is above 0.97 at that temperature.

(6) It should be mobile, free from solid or semisolid bodies, and should flow readily, at ordinary atmospheric temperatures and under a head of 1 foot of oil, through a 4-inch pipe 10 feet in length.

(7) It should not congeal nor become too sluggish to flow at 0° C. (32° F.).

(8) It should have a calorific value of not less than 10,000 calories per gram[a] (18,000 British thermal units per pound); 10,250 calories to be the standard. A bonus is to be paid or a penalty deducted according to the method stated under section 21, as the fuel oil delivered is above or below this standard.[b]

(9) It should be rejected if it contains more than 2 per cent water.

(10) It should be rejected if it contains more than 1 per cent sulphur.

(11) It should not contain more than a trace of sand, clay, or dirt.

---

[a] Calories × 1.8 = British thermal units per pound.

[b] It is important that the standard fixed should not be higher than can be maintained under the terms of the contract. In the absence of information as to the heating value of the oil, the Bureau of Mines will analyze samples taken from the deliveries to establish the standard heating value, expressed in calories or British thermal units. It will be to the best interests of the contractor to specify a fair standard for the fuel oil he offers, since failure to maintain that standard will cause deductions from the contract price and possibly the cancellation of the contract, while deliveries of higher quality than the standard will result in the contractor receiving premiums.

(12) Each bidder must submit an accurate statement regarding the fuel oil he proposes to furnish. This statement should show:

(*a*) The commercial name of the oil.

(*b*) The name or designation of the field from which the oil is obtained.

(*c*) Whether the oil is a crude oil, a refinery residue, or a distillate.

(*d*) The name and location of the refinery, if the oil has been refined at all.

(13) The fuel oil is to be delivered f. o. b. cars or vessel, according to the manner of shipment, at such places, at such times, and in such quantities as may be required, during the fiscal year ending ......

(14) Should the contractor, for any reason, fail to comply with a written order to make delivery, the Government is to be at liberty to buy oil in the open market and charge against the contractor any excess of price, above the contract price, of the fuel oil so purchased.

### SAMPLING.

(15) Deliveries of fuel oil will be sampled by a representative of the Government. Whenever such action is practicable, the oil will be sampled as it is being delivered. The final sample will be made from samples taken from as large a proportion of the delivery as practicable, in order that the final sample may truly represent the delivery.

(16) The final sample will be sealed and forwarded to the Federal Bureau of Mines, Pittsburg, Pa., for analysis.

(17) If the contractor so desires, permission will be given him, or his representative, to witness the sampling of the delivery and the preparation of the final sample.

(18) The final sample will be analyzed and tested immediately after its receipt in Pittsburg.

### CAUSES FOR REJECTION.

(19) A contract entered into under the terms of these specifications shall not be binding if, as the result of a practical service test of reasonable duration, the fuel oil fails to give satisfactory results.

(20) It is understood that the fuel oil delivered during the term of the contract shall be of the quality specified. The frequent or continued failure of the contractor to deliver oil of the specified quality will be considered sufficient cause for the cancellation of the contract.

### PRICE AND PAYMENT.

(21) Payment for deliveries will be made on the basis of the price named in the proposal for the fuel oil corrected for variations in

heating value,[a] as shown by analysis, above or below the standard fixed by the contractor. This correction is a pro rata one and the price is to be determined by the following formula:

$$\frac{\text{Delivered calories per gram (or B. t. u. per lb.)} \times \text{contract price}}{\text{Standard calories per gram (or B. t. u. per lb.).}} = \text{price to be paid.}$$

Water that accumulates in the receiving tank will be drawn off and measured periodically. Proper deduction will be made by subtracting the weight of the water from the weight of the oil deliveries.

## DETERMINATION OF WEIGHT FROM VOLUME.

The specifications given on the preceding pages provide for the purchase of fuel oil by weight. As such oil is frequently delivered by volume, it is important to note the temperature of a delivery and to allow for the expansion due to this temperature when computing the weight of the delivery from the volume. From the volume of the oil at the temperature of delivery, the volume at standard temperature (15° C.) should be computed in the manner given below.

The coefficient of expansion of ordinary fuel oil residues of asphaltic base is approximately 0.0006 per 1° C.

Hence if the temperature (N° C.) of the delivery is above 15° C., then (N° C. – 15° C.) × 0.0006 = correction.

This correction is to be added to the specific gravity at N° C. to give the standard specific gravity, that at 15° C.

If the temperature (N° C.) of the oil delivered is below 15° C., the correction ([15° C. – N° C.] × 0.0006) is to be subtracted from the specific gravity at 15° C.

Since a gallon of water at a temperature of 15° C. weighs 8.3316 pounds, the weight in pounds of a gallon of oil at 15° C. is 8.3316 times the specific gravity of the oil at that temperature.

Similarly, since a cubic foot of water at 15° C. weighs 62.3425 pounds, the weight in pounds of a cubic foot of oil at 15° C. is 62.3425 times its specific gravity at that temperature.

## REPORTING ANALYSES OF FUEL OIL.

The following form is used by the Bureau of Mines in reporting the results of an analysis of a sample of fuel oil:

---

[a] The value of an oil as fuel is in proportion to the total combustible matter it contains as shown by its heating value. This value may be expressed in small calories per gram or B. t. u. per pound. Sulphur, moisture, and earthy matter lower the heating value of an oil and decrease the furnace capacity; they also may have a deleterious effect on boiler and furnace, and may impair the operation of burners.

## DEPARTMENT OF THE INTERIOR.

### BUREAU OF MINES.

Washington, D. C., ............. 191—.

SIR:

In reference to the .......... sample of fuel petroleum representing ............
(Quantity.) (Quantity.)
of petroleum delivered at a temperature of ...... ° C. by the ....................
(Company delivering.)
as a ........................ product, from the ..........., ..................,
(Crude, residue, or distillate.) (Lease.) (Field or district.)
............, ............, to the ...................., at .................. on
(County.) (State.) (Department receiving.) (City.)
.................., I have the honor to report as follows:
(Date of delivery.)

Specific gravity at 15° C ...................................... ......
(Baumé at 59° F.) ........................................ ......
Calories per gram ............................................ ......
(B. t. u. per pound) ...................................... ......
Water, per cent .............................................. ......
Sulphur, per cent ............................................ ......
Earthy matter, sand, etc., per cent .......................... ......
Flash point, ° C. (Abel-Pensky, or Pensky-Martens, closed tester) ......
Burning point, ° C. (same tester, opened) ..................... ......

Remarks:

..............................................................
..............................................................

---

The above information is for the use of the Government and the dealer or operator furnishing the oil. It is to be considered confidential until it is published by the United States Government.

---

Respectfully,

....................
*Chief Clerk.*

Certified:

....................
*Petroleum Chemist.*

## SAMPLING PETROLEUM OR FUEL OIL.

### GENERAL STATEMENT.

The accuracy of the sampling and, in turn, the value of the analysis must necessarily depend on the integrity, alertness, and ability of the person who does the sampling. No matter how honest the sampler may be, if he lacks alertness and sampling ability, he may easily make errors that will vitiate all subsequent work and render the results of tests and analyses utterly misleading. A sampler must be always on the alert for sand, water, and foreign matter. He should note any circumstances that appear suspicious, and should submit a critical report on them, together with samples of the questioned oil.

## SAMPLING WAGON DELIVERIES.

### SAMPLING WITH A DIPPER.

Immediately after the oil begins to flow from the wagon to the receiving tank, a small dipper holding any definite quantity, say 0.5 liter (about 1 pint), is filled from the stream of oil. Similar samples are taken at equal intervals of time from the beginning to the end of the flow—a dozen or more dipperfuls in all. These samples are poured into a clean drum and well shaken. If the oil is heavy, the dipperfuls of oil may be poured into a clean pail, and thoroughly stirred. For a complete analysis the final sample should contain at least 4 liters (about 1 gallon). This sample should be poured into a clean can, soldered tight and forwarded to the laboratory.

It is important that the dipper be filled with oil at uniform intervals of time and that the dipper be always filled to the same level. The total quantity of oil taken should represent a definite quantity of oil delivered and the relation of the sample to the delivery should be always stated, for instance: "1-gallon sample representing 1 wagon-load of 20 barrels."

### CONTINUOUS SAMPLING.

Instead of taking samples with a dipper, it may be more convenient to take a continuous sample. This may be taken by allowing the oil to flow at a constant and uninterrupted rate from a ½-inch cock on the underside of the delivery pipe during the entire time of discharge. The continuous sample should be thoroughly mixed in a clean drum or pail, and at least 4 liters (about 1 gallon) of it forwarded for analysis. A careful examination should be made for water, and if the first dipperful shows water this dipperful should be thrown into the receiving tank and not mixed with the sample for analysis.

### MIXED SAMPLES.

If the oil delivered during any definite period of time, say one month, be from the same source and of uniform quality (but only in case it is of uniform quality), it may suffice to pour definite proportional quantities of the dipper and the continuous samples taken during this period into a tinned can or drum having a tight screw cap or bung. An iron drum should not be used, since even a clean iron surface will absorb sulphur by long contact with a sulphur-containing oil, and this sulphur will be lost to the analyst. At the end of the month a number of round, clean stones should be put into the drum and the drum should be rolled to insure intimate mixing. Then 4 liters (about 1 gallon) of the gross sample should be taken for analysis. The drum should be drained, rinsed clean with gasoline, dried, and made ready for a second sampling.

The all-important point is that the gross sample, whatever the manner of sampling, shall be made up of equivalent portions of oil taken at regular intervals of time, so that the sample finally forwarded for analysis will truly represent the entire shipment.

### SAMPLING A LARGE TANK OR RESERVOIR.

Water or earthy matter settles on standing. Hence before a large stationary tank or a reservoir is sampled the character of the contents at the bottom should be ascertained by dredging with a long-handled dipper, and the contents of the dipper should be examined critically. If a considerable quantity of sediment is brought up, it should be cause for rejecting the oil.

The sampling of a large stationary tank or reservoir of oil, particularly if the oil has stood so long that it has begun to stratify, or form layers of different density, may be done as follows:

The sampler should procure an ordinary iron pipe, or preferably a tinned tube, 1 inch in diameter and long enough to reach from above the manhole, where he can grasp it, to the bottom of the tank. The lower end of the pipe should be reamed out with a round file. A conical plug of cork, wood, or other suitable material should be fitted to this end, and a strong, stiff wire, such as the ordinary telegraph wire, run through this plug and up through the pipe to a point where it can be grasped firmly by the sampler. A pull on the wire will close the bottom of the pipe, and a rap against the bottom of the tank will drive the plug home and make an oil-tight seal or valve.

To operate this sampling device, the sampler should remove the plug, allow it to drop some three inches below the bottom of the pipe, and let it hang there by the wire extending above the pipe. Then holding the pipe, open at top and bottom, in a vertical position, the sampler should allow it to sink slowly through the oil to the bottom of the tank. He should do this slowly and with care, so that the pipe will penetrate the oil without agitating it and will thus cut a representative core of oil from the surface to the bottom. When the pipe touches the bottom, the sampler should draw up the slack of the wire and pull the plug into place; then he should strike the plug smartly against the bottom of the tank, thereby driving it home and sealing the pipe. He can then withdraw the pipe and pour the oil into the sampling can. If it seems desirable, he should "core" or "sample" a reservoir at regularly spaced points, unite these samples, mix them thoroughly, and take 4 liters (about 1 gallon) of the gross sample for analysis.

Instead of a pipe sampler, a bottle holding half a liter (about 1 pint) may be used. It should be securely fastened to a long pole and have a loosely-fitted stopper tied to a strong cord. The bottle, corked and empty, is immersed to any desired point within the mass of the oil, and the stopper is pulled out. The bottleful of oil is poured into a suitable receiving vessel, and the bottle, thoroughly drained, is made ready for a second filling. Bottlefuls of oil taken in this way from points symmetrically placed throughout the mass of the oil, will, if properly mixed, provide an excellent gross sample from which to take the 4-liter (1-gallon) sample for analysis.

### SAMPLING A SINGLE DRUM.

A single drum may be sampled with a glass tube. This tube, open at both ends, should be grasped at the top, held vertically, inserted in the drum without agitating the oil, and allowed to cut its way slowly to the bottom of the drum. The upper end should then be closed with the thumb or forefinger of the hand holding it, the tube withdrawn, and the oil on the outside wiped off with the fingers of the other hand. The sample in the tube can then be transferred to a small can, and forwarded for analysis.

### FORWARDING SAMPLES.

The sample should be forwarded in a glass bottle or carboy or in a tin can, preferably in the latter because less liable to breakage. If a tin can is used the cap should be soldered tight. The can should not be filled completely; about an eighth of an inch of space should be left to allow for possible expansion of the oil.

The can should be sealed as soon as it is filled to avoid loss by volatilization of the lighter constituents of the sample. After the can has been filled and tightly soldered, it should be wiped clean and carefully examined for pinholes or small leaks. All leaks should be soldered before the can is packed for shipment.

The bottle or can should be carefully labeled. The following form of label,[a] used by the Bureau of Mines, should be placed on samples shipped to the bureau:

Department of the Interior.

BUREAU OF MINES.

*Information to accompany each sample of fuel petroleum submitted for analysis.*

Sample number............ Sampled by ........................................
Oil delivered to ............................................................
(Department receiving.)
Place of delivery............................., ..............................
(City.) (State.)
Quantity of oil delivered....................................................
Date of delivery ........................ Temperature of oil as delivered......° C.
Name of contractor...........................................................
Nature of oil ...............................................................
(Crude, residue, or distillate.)
If refined to any degree, state name and location of refinery.................
.............................................................................
Source of oil.............., .................. , ............., ...........
(Lease.) (Field or district.) (County.) (State.)
Remarks: ....................................................................
.............................................................................
.............................................................................
Date of forwarding sample ...................................................
Forwarded by ..............................., via ............................
(Express or fast freight.) (Transportation line.)
.............................................................................

Date of receipt of sample by Bureau of Mines ................................
Condition of sample when received by Bureau of Mines.........................
.............................................................................

---

[a] These labels will be furnished on request.

The label should be carefully written with a hard lead pencil on a strong mailing tag, and this tag should be securely tied to the can. The lead pencil should be pressed firmly against the tag so as to indent its surface. An inscription thus written is legible even after the paper has been wet with oil. Gummed labels should not be used; they are easily detached if slightly moistened, and may be lost. A duplicate copy of the record on the label should be mailed to the engineer in charge, Bureau of Mines, Pittsburg, Pa.

## SAMPLING GAS FROM A WELL.

Since the gas associated with oil is an ideal fuel and illuminant, and the literature dealing with the composition of natural gas is scanty, a description of the method of sampling such gas for analysis is here given.

For taking a sample of gas under pressure from an oil well a cloth funnel should be made by folding and sewing any strong, closely woven cloth into the form of a cornucopia. The larger end of this funnel should be large enough to encompass the gas pipe from which the sample is to be taken. The smaller end, or apex, of the funnel should be securely tied about one end of a flexible rubber tube 1 or 2 feet long and one-fourth to one-half inch in diameter. If there is a gas jet at the well, one end of the rubber tube may be attached directly to the jet.

A gas-sampling bottle should be procured, if practicable, from the Bureau of Mines, Pittsburg, Pa. If such a bottle is not at hand, a 1 or 2 liter (1 or 2 quart) bottle with a well-ground, tight-fitting glass stopper may be used. The bottle should be thoroughly cleansed and dried. A large perfume bottle or an acid bottle, such as may be obtained from a drug store, will usually answer. A glass stopper is essential, for a cork or rubber stopper may leak, even though it appears to be hermetically sealed with wax; moreover, a cork or rubber stopper may contaminate the gas.

To collect a sample, the funnel should be tied firmly about the end of the gas pipe. The funnel and the rubber tube should then be thoroughly flushed with the gas to rid them of air. The free end of the tube should go to the bottom of the sample bottle. The bottle should be fastened bottom up and the gas allowed to blow strongly into it for at least a quarter of an hour to insure complete expulsion of air. If the gas pressure is low, the gas should be allowed to blow longer, or until it is certain that all air has been expelled from the bottle. Meanwhile the stopper of the bottle should have been well greased with vaseline.

While the gas is still blowing through the tube the tube should be slowly withdrawn. The stopper should be put in just as soon as the tube is withdrawn and should be turned firmly into place. Then the bottle should be turned up and a spoonful of melted paraffin poured over the stopper. The stopper should be secured with elastic bands.

A strong tag should be tied to the bottle by a stout cord. This tag should be labeled as follows:

*Gas sample.*

Sampled by..............................
Date........................
Well..................., Lease.......................
(Number)
Section ........, Township..........Range ...........
District........, County...............State........
Remarks ...........................................
..................................................
..................................................

The bottle should be packed securely in a box and forwarded to the Bureau of Mines, Pittsburg, Pa. A duplicate copy of the label should be sent to the same address.

## PUBLICATIONS ON FUEL TESTING.

The following publications, except those to which a price is affixed, may be obtained without cost by applying to the Director, Bureau of Mines, Washington. D. C. The priced publications may be obtained by sending the price, in cash, to the superintendent of documents, Government Printing Office, Washington, D. C.

### PUBLICATIONS OF THE BUREAU OF MINES.

Bulletin 1. The volatile matter of coal, by H. C. Porter and F. K. Ovitz. 1910. 56 pp., 1 pl.

Bulletin 2. North Dakota lignite as a fuel for power-plant boilers, by D. T. Randall and Henry Kreisinger. 1910. 42 pp., 1 pl.

Bulletin 3. The coke industry of the United States as related to the foundry, by Richard Moldenke. 1910. 32 pp.

Bulletin 4. Features of producer-gas power-plant development in Europe, by R. H. Fernald. 1910. 27 pp., 4 pls.

Bulletin 5. Washing and coking tests of coal at Denver, Colo., by A. W. Belden, G. F. Delamater, J. W. Groves, and K. M. Way. 1910. 62 pp.

Bulletin 7. Essential factors in the formation of producer gas, by J. K. Clement, L. H. Adams, and C. N. Haskins. 1911. 57 pp., 1 pl.

Bulletin 8. The flow of heat through furnace walls, by W. T. Ray and Henry Kreisinger. 1911. 32 pp.

Bulletin 9. Recent development of the producer-gas power plant in the United States, by R. H. Fernald. 82 pp. Reprint of United States Geological Survey Bulletin 416.

Bulletin 11. The purchase of coal by the Government under specifications, by G. S. Pope. 80 pp. Reprint of United States Geological Survey Bulletin 428.

Bulletin 12. Apparatus and methods for the sampling and analysis of furnace gases, by J. C. W. Frazer and E. J. Hoffman. 1911. 22 pp.

Bulletin 14. Briquetting tests of lignite at Pittsburg, Pa., 1908–9; with a chapter on sulphite-pitch binder, by C. L. Wright. 1911. 66 pp., 11 pls.

Technical Paper 1. The sampling of coal in the mine, by J. A. Holmes. 1911. 12 pp.

Technical Paper 2. The escape of gas from coal, by H. C. Porter and F. K. Ovitz. 1911. 14 pp.

Original from PRINCETON UNIVERSITY

## PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY.

(Transferred to the Bureau of Mines.)

Bulletin 261. Preliminary report on the operations of the coal-testing plant of the United States Geological Survey at the Louisiana Purchase Exposition, in St. Louis, Mo., 1904; E. W. Parker, J. A. Holmes, M. R. Campbell, committee in charge. 1905. 172 pp. 10 cents.

Professional paper 48. Report on the operations of the coal-testing plant of the United States Geological Survey at the Louisiana Purchase Exposition, St. Louis, Mo., 1904; E. W. Parker, J. A. Holmes, M. R. Campbell, committee in charge. 1906. In three parts. 1,492 pp., 13 pls. $1.50.

Bulletin 290. Preliminary report on the operations of the fuel-testing plant of the United States Geological Survey at St. Louis, Mo., 1905, by J. A. Holmes. 1906. 240 pp. 20 cents.

Bulletin 323. Experimental work conducted in the chemical laboratory of the United States fuel-testing plant at St. Louis, Mo., January 1, 1905, to July 31, 1906, by N. W. Lord. 1907. 49 pp. 10 cents.

Bulletin 325. A study of four hundred steaming tests made at the fuel-testing plant, St. Louis, Mo., 1904, 1905, and 1906, by L. P. Breckenridge. 1907. 196 pp. 20 cents.

Bulletin 332. Report of the United States fuel-testing plant at St. Louis, Mo., January 1, 1906, to June 30, 1907; J. A. Holmes, in charge. 1908. 299 pp. 25 cents.

Bulletin 336. Washing and coking tests of coal and cupola tests of coke, by Richard Moldenke, A. W. Belden, and G. R. Delamater. 1908. 76 pp. 10 cents.

Bulletin 362. Mine sampling and chemical analyses of coals tested at the United States fuel-testing plant, Norfolk, Va., in 1907, by J. S. Burrows. 1908. 23 pp. 5 cents.

Bulletin 363. Comparative tests of run-of-mine and briquetted coal on locomotives, including torpedo-boat tests and some foreign specifications for briquetted fuel, by W. F. M. Goss. 1908. 57 pp., 4 pls.

Bulletin 368. Washing and coking tests of coal at Denver, Colo., by A. W. Belden, G. R. Delamater, and J. W. Groves. 1909. 54 pp., 2 pls. 10 cents.

Bulletin 402. The utilization of fuel in locomotive practice, by W. F. M. Goss. 1909. 28 pp.

O